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Gaps in Canada's Forest Inventory

M. Gillis

Information Report PI-X-78
Petawawa National Forestry Institute

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ABSTRACT

There are some areas of productive forest in Canada not yet covered by forest inventory programs. These gaps occur in transition forest of generally low current commercial value.

Sampling was carried out in the Alberta and Saskatchewan gaps to provide broad but statistically objective estimates of area and volume for Canada's forest inventory.

A network of photo plots was established in each gap. Plots were described by photo interpretation according to 1986 national inventory codes. Volume estimates were interpreted for the stocked productive forest plots. The sample was calibrated with a regression estimator using a subsample of ground plots.

The 5 250 000 hectares of uninventoried productive forest land contains 409 140 810 m^3 of wood, of which 39% is in Alberta, 10% is in southern Saskatchewan, and 51% in northern Saskatchewan.

RÉSUMÉ

Certaines régions forestières productives du Canada ne font pas encore l'objet de programmes d'inventaire forestier. Elles sont situées dans la zone forestière de transition composée d'essences ayant généralement une faible valeur commerciale actuelle.

Des activités d'échantillonnage ont été effectuées dans les régions non inventoriées de l'Alberta et de la Saskatchewan afin d'obtenir des estimations générales mais statistiquement objectives de leur superficie et de leur volume pour l'inventaire des forêts du Canada.

Un réseau de photoplacettes a été établi dans chaque région non inventoriée. Chaque placette a été décrite grâce à la photo-interprétation à l'aide des codes de l'inventaire des forêts du Canada de 1986. Les estimations de volume ont été interprétées dans les placettes forestières boisées productives. L'échantillon a été calibré à l'aide d'un estimateur de régression grâce à un sous-échantillon de placettes au sol.

Les 5 250 000 hectares de terres forestières boisées productives non inventoriées renferment 409 140 810 m^3 de bois dont 39 % sont situés en Alberta, 10 % dans le sud de la Saskatchewan et 51 % dans le nord de la Saskatchewan.

GAPS IN CANADA'S FOREST INVENTORY

INTRODUCTION

Canada's Forest Inventory is a summary of nationwide forest inventory data collected and reported at five-year intervals. Forest inventory in Canada consists of forest type maps and volume sample data. It is periodically updated or replaced. Aerial photography is used in the classification and delineation of forest stands, as well as in the location of photo or ground samples. Ground crews check air photo interpretations and measure selected plots to provide volume information. The volume data are combined with the map to produce area and volume statistics. For national reporting, stand level data, provided to the Canadian Forestry Service by management agencies, are reclassified to the standard national classification system. They are finally combined and summarized to the mapsheet, provincial, and national levels to form Canada's forest inventory (Bonnor 1978, 1982).

In planning the 1986 version of Canada's forest inventory, some large areas containing productive forest were identified as not having been covered by any forest inventory. Obtaining statistics required for national reporting by traditional inventory means was considered too costly and time consuming. As a result, a cooperative project was established to employ a broad sampling design to estimate the area and volume within these inventory gaps.

This report describes areas covered and the sampling design, and presents results of the inventory.

COVERAGE

The inventory gaps extend beyond the limits of forest inventoried by the provinces to the outer limits of land containing productive forest, derived from the Provisional Forest Map of Canada (Forest Mgmt. Inst. 1979) and from provincial input. Gaps are located in the forest-agriculture transition zone of southern Alberta and Saskatchewan and the northern forest-barren transition zone ranging from Saskatchewan to Ontario. Agreement was reached with the Alberta Forest Service and the Saskatchewan Department of Parks and Renewable Resources to survey the prairie forest-agriculture transition zone and the northern Saskatchewan forest-barren zone (Figure 1).

For the purpose of this study, the southern transition zone is divided along provincial boundaries. This created three gaps in total, two southern and one northern. Within a gap the forest is not necessarily contiguous, but may contain two or more physically separated components. As well, for administrative reasons, gap boundaries follow provincial inventory map sheet boundaries.

Figure 1. Forest inventory gaps sampled for Canada's Forest Inventory.

Southern Inventory Gaps

The southern inventory gaps are located in the transition zone between boreal forest and prairie grasslands. The forest is characterized by deciduous species, primarily trembling aspen (Populus tremuloides Michx.), that form continuous, closed stands where conditions are favourable (Figure 2) or open parkland where agricultural land invades (Figure 3) (Rowe 1972). Other characteristic species include balsam poplar (Populus balsamifera L.) on moist lowlands, and white birch (Betula papyrifera Marsh.), bur oak (Quercus macrocarpa Michx.), and white elm (Ulmus americana L.) in eastern Saskatchewan (Rowe 1972). A minor coniferous component is also known to exist. White spruce (Picea glauca [Moench] Voss) occurs in mixed stands with trembling aspen in northeastern Alberta and throughout Saskatchewan. Lodgepole pine (Pinus contorta Dougl. var. latifolia Engelm.) and jack pine (Pinus banksiana Lamb.) exist as pure stands in upland sites in western Alberta.

Tree height varies across the forest-agriculture transition zone from average species height in the continuous stands to low scrubby trees in open parkland. This transition zone is known to contain considerable forest lands of present and potential commercial interest. Provincial forest services are beginning to look at these areas. For example, Manitoba has extended the provincial forest inventory coverage through the transition zone to the United States border.

Northern Inventory Gap

The northern transition zone is extensive in Manitoba and Ontario, but it generally possesses low quality forest and is not of immediate commercial interest. The uninventoried area in northern Saskatchewan does include forest of greater commercial potential. For example, in Saskatchewan more than 50 per cent of the uninventoried gap lies south of the general limits of northern forest inventory in Canada.

The northern inventory gap in Saskatchewan is located in the transition zone between northern boreal forest and subarctic open woodlands. Forest conditions vary from closed, with reasonable height growth in the south (Figure 4), to open lowland park-like conditions in the north (Figure 5). The forest is mostly black spruce (Picea mariana [Mill.] B.S.P.) and jack pine throughout, with white spruce, trembling aspen, and poplar in mixed stands of average height in the river valleys. Frequent fires have been responsible for widespread park-like jack pine forests (Figure 6) (Rowe 1972).

METHOD

The objective of sampling inventory gaps was to obtain a rapid and inexpensive estimate of:

a. area and volume for each land and forest type;

b. area and volume for stocked, productive forest land (gross merchantable hardwood and softwood pulpwood volume)

with a known precision.

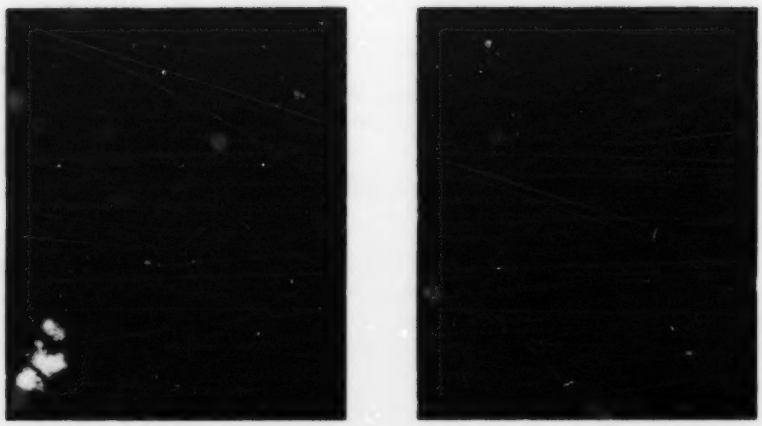


Figure 2. Stereogram of continuous, closed trembling aspen stands in the forest-agriculture transition zone of Saskatchewan (Scale 1:60 000, August 1980).

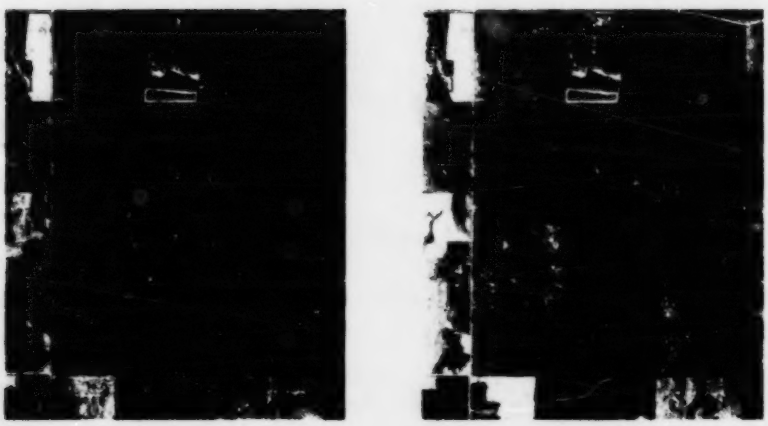


Figure 3. Stereogram of open parkland where agricultural land invades poor quality forest. (Scale 1:60 000, August 1983)

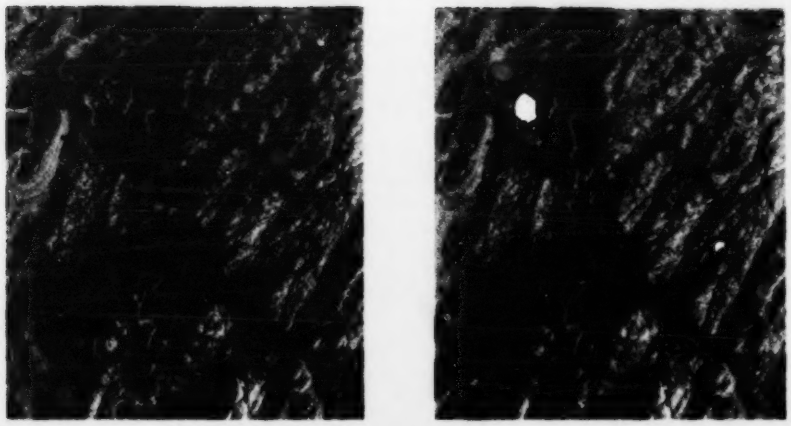


Figure 4. Stereogram illustrating closed forest in the transition forest of northern Saskatchewan (Scale 1:63 360, 1955).

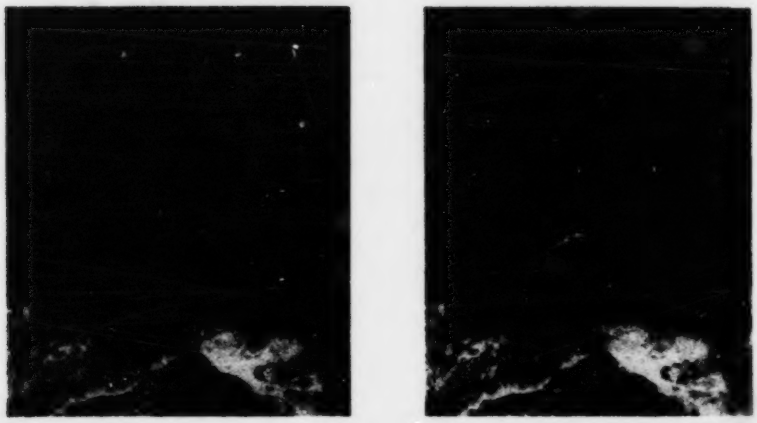


Figure 5. Stereogram of open, lowland, park-like forest in the northern transition gap (Scale 1:50 000, 1977).

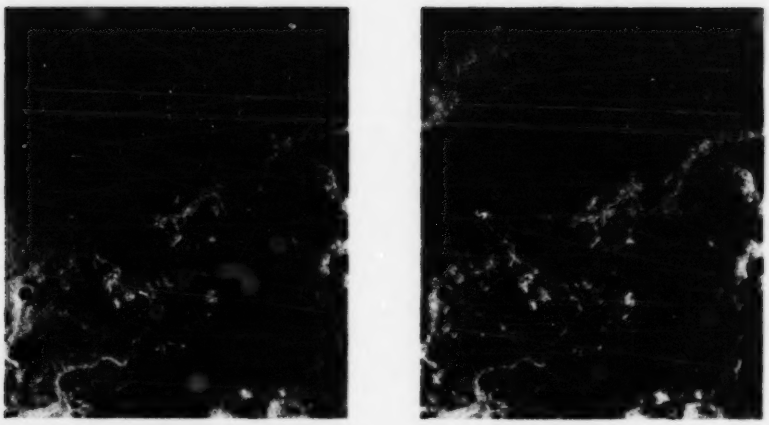


Figure 6. Stereogram of jack pine, park-like forest in northern Saskatchewan (Scale 1:50 000, 1977).

A two-phase sampling design was employed for volume estimation. Land and forest descriptors were sampled using photo plots. The first phase contained photo interpretation estimates of softwood and hardwood pulpwood volumes. The volume estimates were calibrated by the second phase subsample of ground plots (2-phase sample with regression estimator) (Freese 1962, 1984, Husch et al. 1982).

Photo sampling

Three hundred to 500 recent, small- to medium-scale photographs were selected from the photo index for sampling purposes. For each photograph selected, a 1-ha circular plot was located at the principal point, examined stereoscopically to provincial stand mapping specifications, and classified according to the land and forest descriptors located at the centre of the plot. Classification criteria are outlined on the sample worksheet (Figure 7). For plot centres located in stocked productive forest, photo estimates of softwood and hardwood pulpwood volumes (m^3/ha) were made for the whole plot. Mixed plots (those containing parts of stands or land classes other than those found at the plot centre) were moved the shortest distance necessary to fall completely within the stand containing the plot centre.

Ground sampling

For each gap, the ground sample consisted of 15 to 30 plots selected systematically from a random starting point. Each ground plot consisted of three subplots located around the photo plot centre (Figure 8). Each subplot was tallied, compiled separately, and then averaged to generate softwood and hardwood volumes.

A regression of the ground volume on photo volume estimate was calculated. The regression adjustment was applied to all photo volume estimates to obtain the statistical estimate of volume. A separate regression was calculated for hardwood and softwood pulpwood volume within each gap.

Each gap was sampled independently. The Canadian Forestry Service was responsible for the design, layout, photo interpretation, regression analysis, final compilation, and entry into Canada's Forest Inventory 1986. Provincial agencies undertook the ground sampling and initial volume compilation. Ground sampling was not undertaken in northern Saskatchewan due to timing and expense restrictions.

The interpretation was preceded by a short training period at the Petawawa National Forestry Institute and followed by a brief visit to southern Alberta and Saskatchewan.

RESULTS

Results of the surveys are found in Tables 1 and 2 and in Appendix 1. Table 1 shows the volume of stocked, productive forest for the three inventory gaps. These are the 'adjusted' volume figures based on the regression estimator derived from ground plots. Ground plots were not established in northern Saskatchewan. As a result, a precision estimate for volume cannot be made for northern Saskatchewan. Table 2 contains an area and volume summary for stocked, productive forest. Additional tables for individual land and forest types are contained in Appendix 1.

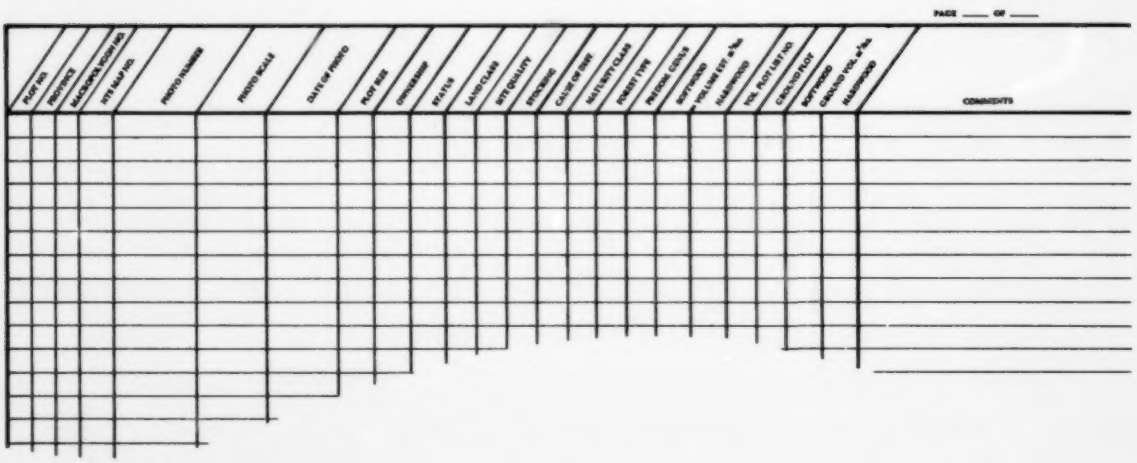
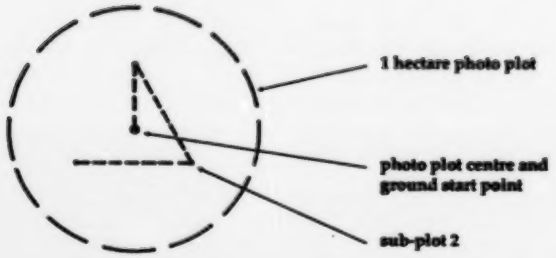


Figure 7. Worksheet layout.



Directions: from the photo plot centre
bearing 0 degrees for 40 m to sub-plot 1;
150 degrees for 70 m to sub-plot 2;
270 degrees for 70 m to sub-plot 3.

Figure 8. Ground plot layout.

Table 1. An estimate of mean softwood and hardwood volumes (gross merchantable m^3 per stocked productive forest area)

Gap	Softwood volume (m^3/ha, 70% CI)		Hardwood volume (m^3/ha, 70% CI)	
Alberta	15	±39%	106	±10%
Saskatchewan (south)	7	±69%	101	±14%
Saskatchewan (north)	65	N/A	10	N/A

Table 2. Area and volume for stocked, productive forest

Gap	Area (ha, 70% CI)		Volume (m^3, 70% CI)	
Alberta	1320804	(± 2%)		
softwood			19812060	(± 39%)
hardwood			140005224	(± 10%)
Saskatchewan S	364072	(± 3%)		
softwood			2548504	(± 69%)
hardwood			36771272	(± 14%)
Saskatchewan N	2800050	(± 2%)		
softwood			182003250	N/A
hardwood			28000500	N/A

DISCUSSION AND CONCLUSION

Several problems were experienced by the interpreter. First, the small scale photography led to difficulties differentiating tree species, height, density, and forest condition. Second, the best available photographs were not always appropriate for this type of interpretation because tree development was not always adequate for accurate interpretation. Third, the print quality of photographs varied somewhat in terms of grey tone contrast, leading to some misinterpretation.

Volume estimation, from aerial photographs in transition forest conditions, was further complicated by the inexperience of the interpreter in photo volume estimation and local ground conditions. For example, the interpreter found it difficult to estimate for merchantable volume small trees near the threshold of merchantability.

Nevertheless, the survey provides a statistically objective estimate of area and volume, of known precision, for these previously uninventoried areas. While there is insufficient information for management-type decisions, the inventory does fill certain gaps in Canada's Forest Inventory as well as provide some new policy level information for the participating provinces.

ACKNOWLEDGMENTS

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Appendix 1. Summary tables

Table a. Area (00 000 ha) by gap and by land class.

Gap	Land Class				
	Water	Nonforest	Unproductive forest	Productive forest	Total
Saskatchewan north	12.51	17.73	24.83	35.84	90.91
Saskatchewan south	0.32	18.10	0.64	3.64	22.70
Alberta	3.30	50.23	2.26	13.21	69.00
TOTAL	16.13	86.06	27.73	52.69	182.61

Totals may not add due to rounding.

Table b. Area of productive forest land (00 000 ha) by gap and by status class.

Gap	Status					
	Reserved	Assigned	Retained	Other	Missing value	Total
Saskatchewan north			35.84			35.84
Saskatchewan south	0.64	0.96		2.03		3.63
Alberta	1.22	0.35	1.74	8.86	1.04	13.21
TOTAL	1.86	1.31	37.58	10.89	1.04	52.68

Totals may not add due to rounding.

Appendix 1. Summary tables (cont'd)

Table c. Area of productive, nonreserved forest land (00 000 ha) by gap and by ownership.

Gap	Ownership				
	Native	Provincial	Unspecified private	Nonindustrial	Total
Saskatchewan N		35.84			35.84
Saskatchewan S	0.43	0.54		2.03	3.00
Alberta		2.09	8.86		10.95
TOTAL	0.43	38.47	8.86	2.03	49.79

Totals may not add due to rounding.

Table d. Area of productive, nonreserved forest land (00 000 ha) by gap and by stocking class.

Province	Stocking Class			
	Partial	Fully	Missing Value	Total
Saskatchewan north	16.05	18.85	0.93	35.83
Saskatchewan south	0.75	2.25		3.00
Alberta	2.09	8.86		10.95
TOTAL	18.89	29.96	0.93	49.78

Totals may not add due to rounding.

Appendix 1. Summary tables (cont'd)

Table e. Area and volume of mature/overmature, stocked, productive, non-reserved forest by gap and predominant genus, area - 00 000 ha
volume - 000 000 m^3

Gap	Predominant genus*							
	Spruce		Pine		Poplar		Total	
	Area	Volume	Area	Volume	Area	Volume	Area	Volume
Saskatchewan north	2.43	26.04	4.48	53.11	0.93	7.37	7.84	6.52
Saskatchewan south					1.07	14.19	1.07	14.19
Alberta	0.35	4.56	0.17	2.14	2.78	36.30	3.30	43.00
TOTAL	2.78	30.60	4.65	55.25	4.78	57.86	12.21	143.71

*Predominant genus is the most abundant genus according to the forest cover type description; usually the first species. Volume incorporates all species in the cover type description.

Totals may not add due to rounding.

Appendix 1. Summary tables (cont'd)

Table f. Area and volume of mature/overmature, stocked, productive, non-reserved forest by gap, forest type and site class,
area - 00 000 ha
volume - 000 000 m^3

Gap	Forest type	Site Class							
		5 - 9.9 m		10 - 14.9 m		15 - 19.9 m		Total	
		Area	Volume	Area	Volume	Area	Volume	Area	Volume
Sask. N	Softwood	2.61	24.92	2.43	27.53	0.19	3.36	5.23	55.81
	Mixedwood	0.56	6.72	1.49	19.60			2.05	26.32
	Hardwood			0.56	4.39			0.56	4.39
Sask. S	Softwood							0.00	0.00
	Mixedwood					0.11	2.08	0.11	2.08
	Hardwood	0.11	0.90	0.75	9.54	0.11	1.67	0.97	12.11
Alberta	Softwood			0.17	2.14			0.17	2.14
	Mixedwood			0.17	2.20	0.17	2.36	0.34	4.56
	Hardwood			2.43	32.29	0.35	4.01	2.78	36.30
Total softwood		2.61	24.92	2.60	29.67	0.19	3.36	5.40	57.95
Total mixedwood		0.56	6.72	1.66	21.80	0.28	4.44	2.50	32.96
Total hardwood		0.11	0.90	3.74	46.22	0.46	5.68	4.31	52.80

Site class expressed in terms of height (m) at age 50 (years).
Totals may not add due to rounding.